Huang 2000-0221

IN THE CLAIMS:

1. (Currently Amended) A method executed in a computer of computing a distance measure between first and second mixture type probability distribution functions, $G(x)=\sum_{i=1}^{N}\mu_i g_i(x)$, pertaining to a set data collected from a first source, and $H(x)=\sum_{k=1}^{K}\gamma_k h_k(x)$, pertaining to another set of collected ~~audio~~ data, the improvement characterized by:

said distance measure being

$$D_M(G,H)=\min_{w=[\omega_{ik}]}\sum_{i=1}^{N}\sum_{k=1}^{K}\omega_{ik}d(g_i,h_k),$$

where $d(g_i, h_k)$ is a function of the distance between a component, g_i, of the first probability distribution function and a component, h_k, of the second probability distribution function where $\sum_{i=1}^{N}\mu_i=1$, $\sum_{k=1}^{K}\gamma_k=1$, $\omega_{ik}\geq 0$ for $1\leq i\leq N$, and for $1\leq k\leq K$, where for at least one value of i $\omega_{ik}>0$ for at least two values of k, and

$$\sum_{k=1}^{K}\omega_{ik}=\mu_i,\ 1\leq i\leq N,\ \sum_{i=1}^{N}\omega_{ik}=\gamma_k,\ 1\leq k\leq K\text{, and}$$

making a determination, based on said computed overall distance as to whether said another set of collected data pertains to said source.

2. (Original) The method according to claim 1 wherein at least one of said first and second mixture probability distribution functions includes a Gaussian Mixture Model.

3. (Previously Presented) The method according to claim 1 wherein the element distance between the first and second probability distance functions is a Kullback Leibler Distance.

4. (Original) The method of claim 1 wherein the first and second probability distribution functions are Gaussian mixture models derived from audio segments.

5. (Currently Amended) A computer program embedded in a storage medium for computing a distance measure between first and second mixture type probability distribution functions, $G(x)=\sum_{i=1}^{N}\mu_i g_i(x)$, pertaining to a set data collected from a first source, and $H(x)=\sum_{k=1}^{K}\gamma_k h_k(x)$, pertaining to another set of collected ~~audio~~ data, the improvement comprising a software module of said computer program that evaluates said distance measure in accordance with equation:

$$D_M(G,H)=\min_{w=[\omega_{ik}]}\sum_{i=1}^{N}\sum_{k=1}^{K}\omega_{ik}d(g_i,h_k),$$

where $d(g_i, h_k)$ is a function of distance between a component, g_i, of the first probability distribution function and a component, h_k, of the second probability distribution function where

$$\sum_{i=1}^{N}\mu_i=1 \ \ and \ \sum_{k=1}^{K}\gamma_k=1,$$

$$\omega_{ik}\geq 0,\ 1\leq i\leq N, 1\leq k\leq K,$$

there exists some value of i for which $\omega_{ik}>0$ for at least two values of k, and

$$\sum_{k=1}^{K}\omega_{ik}=\mu_i,\ 1\leq i\leq N,\ \sum_{i=1}^{N}\omega_{ik}=\gamma_k,\ 1\leq k\leq K$$, and

making a determination, based on said computed overall distance as to whether said another set of collected data pertains to said source.

6. (Original) The computer program according to claim 5 wherein at least one of said first and second mixture probability distribution functions includes a Gaussian Mixture Model.

7. (Original) The computer program according to claim 5 wherein the element distance between the first and second probability distance functions includes Kullback Leibler Distance.

8. (Original) The computer program of claim 5 wherein the first and second probability distribution functions are Gaussian mixture models derived from audio segments.

9. (Previously Presented) A computer system for computing a distance measure between first and second mixture type probability distribution functions,

$G(x)=\sum_{i=1}^{N}\mu_i g_i(x)$, and $H(x)=\sum_{k=1}^{K}\gamma_k h_k(x)$, pertaining to audio data comprising:

memory for storing said audio data;

a processing module for deriving one of said mixture type probability distribution functions from said audio data; and

a processing module for evaluating said distance measure in accordance with

$$D_M(G,H)=\min_{w=[\omega_{ik}]}\sum_{i=1}^{N}\sum_{k=1}^{K}\omega_{ik}d(g_i,h_k),$$

where $d(g_i, h_k)$ is a function of the distance between a component, g_i, of the first probability distribution function and a component, h_k, of the second probability distribution function,

where

$$\sum_{i=1}^{N}\mu_i=1 \ \ and \ \sum_{k=1}^{K}\gamma_k=1,$$

and

$$\omega_{ik}\geq 0,\ \ 1\leq i\leq N, 1\leq k\leq K,$$

and there exists some value of i for which $\omega_{ik}>0$ for at least two values of k,

and

$$\sum_{k=1}^{K}\omega_{ik}=\mu_i,\ 1\leq i\leq N,\ \sum_{i=1}^{N}\omega_{ik}=\gamma_k,\ 1\leq k\leq K.$$

10. (Original) The computer system according to claim 9 wherein at least one of said first and second mixture probability distribution functions includes a Gaussian Mixture Model.

11. (Original) The computer system according to claim 9 wherein the element distance between the first and second probability distance functions includes Kullback Leibler Distance.

12. (Original) The computer system of claim 9 wherein the first and second probability distribution functions are Gaussian mixture models derived from audio segments.

13. (Currently Amended) A method executed in a computer for computing a distance measure between a mixture type probability distribution function $G(x)=\sum_{i=1}^{N}\mu_i g_i(x)$, pertaining to a set data collected from a first source, where μ_i is a weight imposed on component, $g_i(x)$, and a mixture type probability distribution function $H(x)=\sum_{k=1}^{K}\gamma_k h_k(x)$, pertaining to another set of collected data, where γ_k is a weight imposed on component h_k comprising the steps of:

computing an element distance, $d(g_i, h_k)$, between each g_i and each h_k where $1 \le i \le N, 1 \le k \le K$,

computing an overall distance, denoted by $D_M(G,H)$, between the mixture probability distribution function G, and the mixture probability distribution function H, based on a weighted sum of the all element distances,

$$\sum_{i=1}^{N}\sum_{k=1}^{K}\omega_{ik}d(g_i,h_k),$$

wherein weights $\omega_{i,k}$ imposed on the element distances $d(g_i, h_k)$, are chosen so that the overall distance $D_M(G,H)$ is minimized, subject to

$\omega_{ik} > 0$ for at least two values of k for each value of i.

$\cancel{\omega_{ik} \ge 0, 1 \le i \le N, 1 \le k \le K}$

$$\sum_{i=1}^{N} \omega_{ik} = \gamma_k,\ 1 \le k \le K,\ \text{and}$$

$$\sum_{k=1}^{K} \omega_{ik} = \mu_i,\ 1 \le i \le N,\ \text{and}$$

making a determination, based on said computed overall distance as to whether said another set of collected data pertains to said source

~~there exists some value of i for which $\omega_{ik} > 0$ for at least two values of k~~.

14. (Original) The method according to claim **13** wherein at least one of said first and second mixture probability distribution functions includes a Gaussian Mixture Model.

15. (Original) The method according to claim **13** wherein the element distance between the first and second probability distance functions includes Kullback Leibler Distance.

16. (Original) The method of claim **13** wherein the first and second probability distribution functions are Gaussian mixture models derived from audio segments.

17. (Previously Presented) A method executed in a computer for content-based searching of stored data comprising the steps of:

identifying segments in said data;

developing a probability distribution function for each of said segments from data points within each of said segments;

developing a distance measure between a probability distribution function of a chosen data segment and probability distribution function for said segments; and

applying a threshold to the developed distance measure to identifying segments with a distance measure relative to said chosen data segment that is below a preselected threshold value, where said distance is directly computed according to a measure that guarantees to satisfy the non-negativeness, symmetry, and triangular inequality properties of a distance measure.

18. (Previously Presented) Them method of claim **17** where said chosen data segment is one of said segments, or a provided data segment.

19. (Previously Presented) The method of claim **17** where said stored data is audio-visual data.

20. (Previously Presented) The method of claim **17** where said stored data comprises segments that carry speech of a speaker.

21. (Previously Presented) The method of claim **20** where a segment of said segments is characterized by a speaker that predominates an audio signal associated with said segment.

22. (Previously Presented) The method of claim **20** where said chosen segment is a segment that carries speech of a particular speaker.

23. (Previously Presented) The method of claim **17** where said data is of a television program.

24. (Previously Presented) The method of claim **17** where said distance measure between a first probability function, $G(x)=\sum_{i=1}^{N}\mu_i g_i(x)$, and a second probability function, $H(x)=\sum_{k=1}^{K}\gamma_k h_k(x)$, is

$$D_M(G,H)=\min_{w=\{\omega_{ik}\}}\sum_{i=1}^{N}\sum_{k=1}^{K}\omega_{ik}d(g_i,h_k),$$

where

- $d(g_i, h_k)$ is a function of the distance between a component, g_i, of the first probability distribution function and a component, h_k, of the second probability distribution function,

- $\sum_{i=1}^{N} \mu_i = 1 \;\; and \;\; \sum_{k=1}^{K} \gamma_k = 1$,
- $\omega_{ik} \geq 0,\ 1 \leq i \leq N, 1 \leq k \leq K$,
- $\sum_{k=1}^{K} \omega_{ik} = \mu_i,\ 1 \leq i \leq N,\ \sum_{i=1}^{N} \omega_{ik} = \gamma_k,\ 1 \leq k \leq K$, and
- there exists some value of *i* for which $\omega_{ik} > 0$ for at least two values of *k*.

25. (Previously Presented) A method executed in a computer comprising the steps of:

identifying speaker segments in provided audio-visual data based on speech contained in said data;

developing a probability distribution function for each of said segments from data points within each of said segments; and

developing distance measures among said probability distribution functions, where each of said measures is obtained through a one-pass evaluation of a function that guarantees to satisfy the non-negativeness, symmetry, and triangular inequality properties of a distance measure.

26. (Previously Presented) The method of claim **25** where said distance measure between a first probability function, $G(x) = \sum_{i=1}^{N} \mu_i g_i(x)$, and a second probability function, $H(x) = \sum_{k=1}^{K} \gamma_k h_k(x)$, is

$$D_M(G,H) = \min_{w=[\omega_{ik}]} \sum_{i=1}^{N} \sum_{k=1}^{K} \omega_{ik} d(g_i, h_k),$$

where

- $d(g_i, h_k)$ is a function of the distance between a component, g_i, of the first probability distribution function and a component, h_k, of the second probability distribution function,
- $\sum_{i=1}^{N} \mu_i = 1 \;\; and \;\; \sum_{k=1}^{K} \gamma_k = 1$,

Huang 2000-0221

- $\omega_{ik} \geq 0,\ 1 \leq i \leq N, 1 \leq k \leq K$,
- $\sum_{k=1}^{K} \omega_{ik} = \mu_i, 1 \leq i \leq N, \sum_{i=1}^{N} \omega_{ik} = \gamma_k, 1 \leq k \leq K$, and
- there exists some value of *i* for which $\omega_{ik} > 0$ for at least two values of *k*.